

REMARKS

I. PENDING CLAIMS AND SUPPORT FOR AMENDMENTS

Upon entry of this amendment, claims 1, 2, and 6-18 will be pending in this application. Claims 3-5 have been canceled. Claims 14-18 have been withdrawn by the Examiner as directed to a non-elected invention.

Applicants have amended claim 1 to delete the term “continuously” which as been criticized by the Examiner, and replace it with the term “intermittently,” which is supported by the specification at, inter alia, page 9, which describes the spraying of water into the reactor to form aqueous sodium hydroxide, increasing pressure within the reactor turns off a water pump, and when the pressure drops again, water is again sprayed into the system. Other intermittent flow embodiments are disclosed elsewhere in the specification. The specification clearly indicates that the inventors had possession of intermittent flow of aqueous solution in the reactor as of the filing date of the invention, and no new matter has been added by the present amendment.

II. REJECTION UNDER 35 U.S.C. § 112

At page 2 of the Office action, the Examiner has rejected claims 1, 2, and 6-13 under 35 U.S.C. § 112, first paragraph as directed to subject matter not described in the specification. Applicants respectfully traverse this rejection and request reconsideration and withdrawal thereof.

Specifically, the Examiner objects to the terminology “continuously” introducing a flow stream of aqueous liquid into a reaction vessel. While Applicants remain convinced that such terminology is fully supported by the specification, in the

spirit of cooperation, Applicants have amended the claims to recite that the flow stream is intermittently introduced into the reactor, as is clearly supported by the disclosure pointed out above. Accordingly, the Examiner's rejection is rendered moot and should be withdrawn.

III. REJECTION UNDER 35 U.S.C. § 103(a)

At page 2 of the Office action, the Examiner has rejected claims 1, 2, and 6-13 as obvious over Andersen et al. (U.S. Patent No. 6,506,360). Applicants respectfully traverse this rejection and request reconsideration and withdrawal thereof.

Applicants respectfully submit that Andersen et al. is (1) inaccurate in its description of its own process and (2) completely fails to teach or suggest Applicants' claimed invention.

First, Andersen et al. suggest that the sodium hydroxide present in its process is a catalyst. See column 2, line 49. However, this is not the case, at least in Applicant's claimed process, as the sodium hydroxide participates in the process as a reactant. Similarly, there is no catalytic reaction of aluminum with water as Andersen et al. state at column 3, line 51. Instead, aluminum oxide, formed on the surface of aluminum, and sodium hydroxide react to form sodium-aluminum hydroxide; there is no direct catalytic reaction of aluminum with water. The sodium hydroxide reacts with aluminum oxide on the surface of the aluminum, allowing more aluminum to oxidize and react further to form aluminates which go into solution as ionic species and form hydrogen gas.

Second, Andersen et al. fail to realize that their disclosed “active” phase B, which is disclosed to be a constant temperature phase at column 7, line 26, is in reality a phase of reaction where the amount of heat released increases over time, as the exothermic reaction heats both the water and the reactants. The result is an increase in pressure, which Andersen et al. does not recognize to be a potential problem, and does not attempt to control successfully.

As the pressure increases in the reactor of Andersen et al., generated hydrogen causes the bellows within the device to expand, lifting the fuel cell of Andersen et al. from contact with the water. This does not, as Andersen et al. apparently expect, reduce the rate and amount of reaction. Because the fuel cell in Andersen et al. consists of strips of paper impregnated with crystalline sodium hydroxide and aluminum particles, the paper retains a significant amount of fluid by absorption and capillary action, which continues to react with the sodium hydroxide and aluminum. Reaction will thus continue for a significant period of time (continuing to increase pressure in the device) after the paper has been removed from the water. Moreover, a significant quantity of water vapor will be present, which is also available to react with the sodium hydroxide and aluminum, even after the “pressure control” has been activated. This water vapor will also cause an increase in heating as it reacts with the hygroscopic sodium hydroxide, driving the temperature well above the 45 °C level desired by Andersen et al.

By contrast, the present invention uses a combination of a dry mixture of dissociation initiating materials and reactants and the injection of specific volumes of

water at specific timed intervals to control the reaction. When a specific volume of water is injected into the reactor, a portion of the dry sodium hydroxide immediately dissolves, releasing significant heat, and rapidly increasing the temperature of the water and reactants. This heat causes the water to dissociate, with the oxygen being complexed by the sodium-aluminum hydroxide, leaving the hydrogen available as a gas. Because of the small quantities of water used, the water is consumed and the dissociation is completed rapidly, with a controlled, proportionate increase in hydrogen pressure in the reactor. Additional injections of metered amounts of water at specified times add further to the hydrogen pressure, until the desired pressure level is reached, at which time further injection of water is not made.

The reactor is dormant in a safe state, where no further reaction can occur, until some hydrogen is removed for use. Additional controlled amounts of water can then be injected again until the desired pressure is reached. The volume of water injected and the timing of the injections can be precisely varied to precisely control the volume of hydrogen given off, and the hydrogen pressure inside the reactor. This can be keyed to the end use, so that the reactor provides a safe, replenishable reservoir of high pressure hydrogen available for the desired end use. The process and device disclosed in Andersen et al. is incapable of this level of pressure control, for the reasons explained above. Moreover, unlike the Andersen et al. process, the process of this invention is scalable to any size application.

In addition, one embodiment of the invention is particularly suitable for producing the volumes of hydrogen gas needed to run an internal combustion engine,

while maintaining a practical reactor size. In this embodiment, only the metallic aluminum is contained in the pressure reactor (instead of aluminum and sodium hydroxide, as above), and the sodium hydroxide solution is metered into the reactor from a solution reservoir of saturated aqueous solution. Water is flowed through a bed of sodium hydroxide and then into the solution reservoir, in order to replace water consumed in the dissociation reaction. To control the exothermic reaction, solution is removed from the reactor with each incremental change in temperature, thereby reducing the surface area of solution in contact with the aluminum (and without using any absorbent, water-wicking material, as does Andersen et al.). A constant volume of high pressure hydrogen gas is available for release through a pressure regulator; the reactor pressure is controlled by constant monitoring of the temperature and the liquid level, and by varying the liquid level in response to incremental temperature changes, precise control over the volume of hydrogen gas generated is achieved. Again, this embodiment achieves a level of control not obtainable with the water-wicking apparatus of Andersen et al. The embodiment is also very scalable from small scale fuel cell volumes to those needed to power electrical turbine generators.

The two embodiments of the claimed invention described above provide precise control of a hydrogen generation reaction; Andersen et al. provide only a cursory “on” and a gradual “off” for the reactions. Andersen et al. is therefore not scalable to any applications requiring significant volumes of high pressure hydrogen gas per unit time, and does not the control temperature of reactants or the solution.

Because Andersen et al. fails to teach or suggest Applicants' claimed invention, the Examiner has failed to establish a prima facie case of obviousness, and this rejection should be withdrawn.

The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Order Account No. 11-0855.

Respectfully submitted,



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